

# Mac and PC Performance Analysis

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## Table of Contents

|                                     |     |
|-------------------------------------|-----|
| Table of Contents.....              | ii  |
| Abstract.....                       | iii |
| Introduction.....                   | 1   |
| Materials and Methods.....          | 2   |
| Results.....                        | 5   |
| The best tool for benchmarking..... | 5   |
| The fastest OS on an Intel Mac..... | 6   |
| The difference hardware makes.....  | 7   |
| Comparison of Vista and XP.....     | 7   |
| Discussion and conclusions.....     | 8   |
| Future Work.....                    | 8   |
| Acknowledgements.....               | 8   |
| References.....                     | 9   |
| Tables.....                         | 10  |
| Figures.....                        | 12  |

## **ABSTRACT**

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Over the course of the past year, the desktop environment at Berkeley Lab has been impacted by improvements in hardware and changes in operating system software. The performance of a computer is based on a combination of the operating system being used and the computer's hardware. In order to evaluate the contributions of these different factors, benchmarking software was used on the systems. The benchmarking products used were GeekBench, from Primate Labs, CineBench, from MAXON, (cross-platform) and PerformanceTest, from PassMark (only available for Windows). A recommendation for a single lab benchmark product was not made, because each one employed unique criteria, thus making it difficult to select a "best" tool. Experiments were done on a variety of common desktop and laptop systems, from Apple, Dell, and MPC. These systems spanned the range of processors from the older Pentium 4 through the latest Quad Core Xeon processor. Research validated my expectation that hardware makes a significant difference on computer performance. The research showed that the fastest operating system on an Intel Mac was Mac OS X Leopard, which was a full 15% faster than Windows Vista on the same hardware. In addition, Windows Vista is not significantly slower than XP, based on the results of the selected benchmarking tools used in this research.

## **1. Introduction**

The computer industry is one that is constantly changing; the leading manufacturers of processors, Intel and AMD, release major revisions to their hardware on a regular basis. In addition, companies such as Microsoft and Apple are constantly releasing updates to their operating systems. The ever-changing nature of the industry can have a heavy impact on business decisions made by companies who standardize their desktop environments.

On January 30, 2007, Microsoft unleashed their latest operating system (OS), Windows Vista, to the public. Since then, Lawrence Berkeley National Laboratory (LBNL) has been working to address two main issues. The first issue is that Windows XP, Microsoft's most popular client OS, is now no longer being sold to consumers (though LBNL can still purchase downgrade rights to XP when ordering a system with Vista). In light of this, LBNL must decide whether to continue using XP or make the switch to Vista. Another issue to address is the growth of Mac usage at the Lab. For example, the newly formed Joint BioEnergy Institute, as well as the Molecular Foundry. Both have higher than normal Mac adoption. This research is being done with Lawrence Berkeley Laboratory's Information Technology Division, in the Mac/PC workstation support group. With Microsoft's move to Vista, LBNL (as well as many other companies and users) are debating the ramifications of upgrading to Vista or increasing support for the Macintosh platform.

To some users, the OS they use is irrelevant. The choice of operating system is driven by the need for specific research software tools and the platforms those tools are deployed on. People have debated the issue of operating systems for years - every time an OS is released, it is a certainty that there will be a myriad of important questions about it. It is important to find answers for exactly these kinds of questions, because they can directly

influence the decisions of information technology decision makers. Specifically, I intend to focus on finding the answers to four different questions: "What is the best (or most appropriate) benchmarking tool?", "What is the fastest OS on an Intel Mac?", "How does hardware impact performance?", and finally "How does Windows Vista compare (performance-wise) to Windows XP?" As a bi-product of research related to these four questions, the difference that service packs make on Windows operating systems was also investigated.

The benchmarking products used were GeekBench, from Primate Labs, CineBench, from MAXON, (cross-platform) and PerformanceTest, from PassMark (only available for Windows). See Table 1 for a description of what each tool measures. Benchmarking is a popular way to measure a computer's performance[1]. A benchmarking program instructs a computer to perform a specific set of pre-defined tasks and measures the time it takes to complete those tasks.

## **2. Materials and Methods**

In this research, Experiments were done on a variety of common desktop and laptop systems, from Apple, Dell, and MPC. These systems spanned the range of processors from the older Pentium 4 through the latest Quad Core Xeon processor. Table 2 contains a list of the desktops used, while Table 3 contains the laptops. The systems were tested using four different tools. A description of the tools used is given below.

**GeekBench[2]:** a cross-platform benchmark tool that measures processor and memory performance. It tests floating-point performance, integer performance, memory performance, and streaming performance.

**CineBench[3]:** a cross-platform tool that runs several tests on a system to measure the capabilities of its processor(s) and graphics card(s) in real-world situations. CineBench performs two main tests on a system. In the first test, a realistic image is rendered using only the main processing core, and then using all available processing cores. In the second test, a 3D animation is played back, rendered in real-time using only the GPU, in order to test the card's ability to render the scene in the shortest possible amount of time.

**PassMark PerformanceTest[4]:** a Windows-only tool that allows you to perform a complete benchmark on a system by running a wide variety of tests and giving the option to compare the results to those of other computers. PassMark performs CPU tests, 2D graphics tests, 3D graphics tests, Disk tests, and Memory tests, CD / DVD tests.

**OfficeBench[5]:** this is a completely version-independent testing suite that performs a large number of common tasks within any Microsoft Office environment. It then presents the user with information regarding how long it took to complete the set of tasks.

In order to conduct these benchmarking tests, some additional tools were required. These tools included:

**OnyX:** a free third-party application designed to defragment and optimize Macintosh computers. Mac OS X Leopard does not include a built-in disk defragmentation utility, but it is worth noting that the operating system defragments itself in the background after most file operations, as well as automatically at 3:00 AM each night (assuming the system is running at that time). OnyX was used in these tests to force a defragmentation, ensuring that each system tested was optimized in as close to the same way as possible.

**Boot Camp:** a free utility made by Apple that comes built into Mac OS X Leopard. It is used to create a Windows partition on a Mac and assist in the process of completing a Windows

installation on the system. It also generates a special set of drivers that allow Windows to function properly on Apple hardware.

Before beginning any testing, it was important to come up with a standard test protocol to use. This was done to ensure that there were no outside factors having an effect on system performance. These protocols are outlined below.

On the PC platform, two operating systems were used: Windows XP and Windows Vista. For the Windows XP tests, both Service Pack 2 and the newly released Service Pack 3 were tested. A fresh install of XP with Service Pack 2 was done, and the system optimized using two different methods. Optimization is the process of making sure a system is running ideally. Once the operating systems were installed, the systems were rebooted three times. This is done because, according to Microsoft[6], during the first several times Windows is booted, the OS looks at the system and decides which files need to be pre-loaded, which can have variable effects on performance. The second optimization that was done is a simple disk defragmentation, performed twice. The systems were rebooted after each defragmentation, for a total of five reboots during the optimization process. The standard Windows disk defragmentation tool was used.

After performing the optimizations on the systems, the benchmarking tools to be used were installed and run. We executed the benchmarks five times, which enabled us to get the average of the scores. The results were then obtained and analyzed. After this, the same system was upgraded to XP Service Pack 3, and the process was repeated.

For the Windows Vista tests, the original Release to Manufacturing (RTM) version was tested first. A clean install was done. After optimizing the system, the tools were installed and run. The results were then obtained. After cataloguing the results, the system

was upgraded to Service Pack 1, and the same process repeated.

For the Macintosh tests, Mac OS Leopard 10.5.3 was installed on our test systems. The systems were then optimized using OnyX, which was used to defragment the system and verify the disk permissions. The tools were then installed and run, and the results obtained and catalogued. For the tests involving running Windows on a Mac, Boot Camp was used. The process of using Boot Camp involved creating a 32 GB Windows partition on the Mac's hard drive, installing and optimizing Windows using the process described above, and installing a special set of drivers that allow Windows to function correctly on Apple's hardware. The tests were then run, and the results collected.

### **3. Results**

#### ***Best tool for benchmarking:***

A variety of different benchmarking tools were used. The cross-platform programs that were used were CineBench and GeekBench. We also used PassMark PerformanceTest, which is very thorough but is not cross-platform. The tools that were used each have their own set of different parameters to examine for benchmarking, as illustrated in Table 1, which makes comparing the programs difficult. For example, while CineBench looks only at graphics and processing, GeekBench does not examine graphics performance at all. Another example is that PassMark and GeekBench both provide an overall rating of the system, while CineBench does not. However, for the purposes of these tests, the average of the three results CineBench does give can be found and used as an average. From this research, we see that PassMark gives an extremely detailed result, but it is impossible to objectively state that it is a better benchmarking tool than GeekBench or CineBench. See Table 1 for an aggregate level view of what each program examines.

It is important to note that these generic benchmarks do not necessarily reflect what an individual user may experience; for example, if someone interested in playing games were to depend on GeekBench, they might be disappointed (due to the fact that it does not measure video performance). That user would, instead, want to use a tool like 3DMark, which focuses solely on real-world gaming benchmarks. Similarly, if someone wanted to know how well Office would run on their system, they'd want to use a tool like OfficeBench, which examines real-world Office workloads on a system.

### ***Which operating system is faster on an Intel Mac?***

In this research, it was only possible to test the Mac OS on true Apple hardware. This is because Windows runs on Macintosh-based computers, but Windows-based computers will not run Mac OS X. The Mac OS is the fastest operating system in these tests (on a new MacBook), as is evidenced by Figure 1. Figures 2 and 3 demonstrate that GeekBench and CineBench (respectively) indicate that the same is true on a new MacBook Pro. Our GeekBench results that Windows Vista is approximately 15% slower than Leopard, while XP is about 14% slower than Leopard. This research has clearly demonstrated that Mac OS X Leopard runs noticeably faster on a Mac than Windows XP or Windows Vista do. These results also seem to confirm that Vista is not much slower than Windows XP (which is further discussed later in this paper).

An interesting observation we made is that our research results seem to indicate that Windows XP and Vista may perform better on Apple hardware than on a nearly identical (specification-wise) Windows-based machine. However, due to time constraints, we were unable to pursue this further.

### ***How much difference does the hardware platform make?***

Since a number of different hardware platforms were tested in this research, a part of the study was to determine how much difference hardware makes on performance. As is demonstrated in Figure 4, performance is proportional to the hardware; as higher-end hardware is introduced, performance increases. This trend can also be seen in Figure 5, where we note that the Precision workstation has more than double the scores of the Optiplex line. We also compared a MacBook and Latitude D630, which have identical specifications (except for the Latitude D630's dedicated video card, which can be ignored since GeekBench does not measure video performance). The results of these tests can be seen in Figure 4. Similarly, an Optiplex 745 and an Optiplex 755, which is newer by one year, were compared in Figure 6. It is interesting to note that the difference in processor speeds between the Optiplex 745 and 755 makes a significant difference in performance.

### ***Is there a difference between Vista and XP?***

In all of the tests done for this research, Vista was not significantly different from XP in speed. Quite interestingly, the installation of Vista's first service pack does not seem to make a significant difference in performance, though Microsoft claims that performance boosts are a key feature of the update. Vista is certainly slower than XP, but according to our PassMark results (see Figure 7) the difference is small enough that a common user would not even notice the difference. As Figure 8 indicates, GeekBench agrees with PassMark's results. After examining these results thoroughly, I feel it is safe to say that Windows Vista is *not* significantly slower than XP, despite what the media would have us believe. It is important to note, however, that these generic benchmarking tools do not necessarily reflect what a user may experience in real-world situations.

#### **4. Discussion and Conclusions**

Due to the results of my tests, I can say with some certainty that the Mac OS is faster than Windows, at least on the same hardware. It can also be said that, judging by the results given by each program I used, Windows Vista is *not* significantly slower than Windows XP.

For tests done solely on Windows-based systems, the best benchmarking tool is probably PassMark, due to the thoroughness of its results. For testing that requires a cross-platform tool, I'd advise the usage of both GeekBench and CineBench; GeekBench provides an excellent look at processor and memory performance, and CineBench gives a detailed look at graphics capabilities.

#### **5. Future Work**

Due to the ever-changing nature of computer hardware, benchmarking tests have become a process that must be repeated every time a hardware revision is released to the public. Software plays an equally important role, however; in the near future, Microsoft plans to release Windows 7, and Apple is slated to release Mac OS 10.6 "Snow Leopard". When these new operating system revisions are released to the public, performing benchmarking tests on them will be necessary before LBNL can consider upgrading to either of them.

#### **6. Acknowledgments**

This research was completed at Lawrence Berkeley National Laboratory. I would like to thank Charles Verboom, my mentor, and Zachariah Tanko, my FaST team member, for their assistance and support. I would also like to thank the Office of Science, Lawrence Berkeley National Laboratory, CSEE, and the FaST program for allowing me to participate in this

internship.

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[1] "Mac VS PC: The Ultimate Lab Test for new Desktops and Laptops" Popular Mechanics

<http://popularmechanics.com/technology>

[2] "Primate Labs GeekBench" Primate Labs

<http://primatelabs.ca/geekbench/index.html>

[3] "MAXON CineBench" MAXON

[http://www.maxon.net/pages/download/cinebench\\_e.html](http://www.maxon.net/pages/download/cinebench_e.html)

[4] "PassMark PerformanceTest" PassMark

<http://www.passmark.com/products/pt.htm>

[5] "OfficeBench" exo.performance.network

<http://www.xpnet.com/>

[6] "Benchmarking on Windows XP: Home Edition and Professional" Microsoft

<http://www.microsoft.com/whdc/archive/benchmark.mspx>

## TABLES

|                | GeekBench | CineBench | PassMark |
|----------------|-----------|-----------|----------|
| Floating Point | x         |           |          |
| Integer        | x         |           |          |
| Memory         | x         |           | x        |
| Stream         | x         |           |          |
| 1 CPU          | x         | x         | x        |
| 2 CPU          | x         | x         | x        |
| Graphics       |           | x         | x        |
| Disk Mark      |           |           | x        |
| CD Mark        |           |           | x        |
| Overall        | x         |           | x        |
|                |           |           |          |
|                |           |           |          |
|                |           |           |          |

**Table 1 - Comparison of Benchmarking Tools**

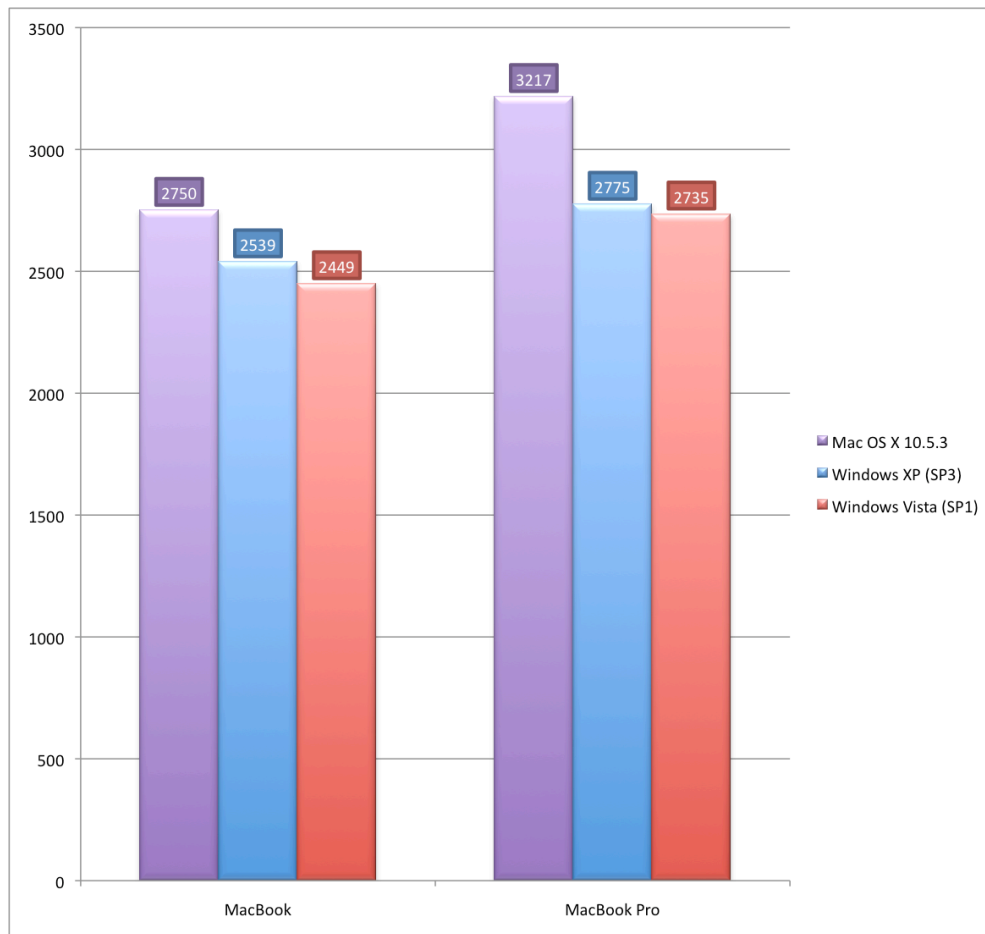
|      | Dell Optiplex 745           | Dell Optiplex 755          | Dell Precision 5400     | MPC ClientPro 365         |
|------|-----------------------------|----------------------------|-------------------------|---------------------------|
| Cost | \$887                       | \$823                      | \$2629                  | \$1594                    |
| CPU  | Core 2 Duo, 2.13 GHZ        | CPU: Core 2 Duo, 3.0 GHZ   | Quad Core Xeon, 2.5 GHZ | Pentium 4, 3.4 GHZ        |
| RAM  | 2 GB                        | 2 GB                       | 8 GB                    | 512 MB                    |
| GPU  | Radeon HD 2400 Pro - 256 MB | Radeon HD 2400 XT - 256 MB | Quadro FX1700 - 512 MB  | GeForce PCX 5750 - 128 MB |
| HDD  | 148 GB                      | 250 GB                     | 160 GB                  | 100 GB                    |

**Table 2 - List of desktops**

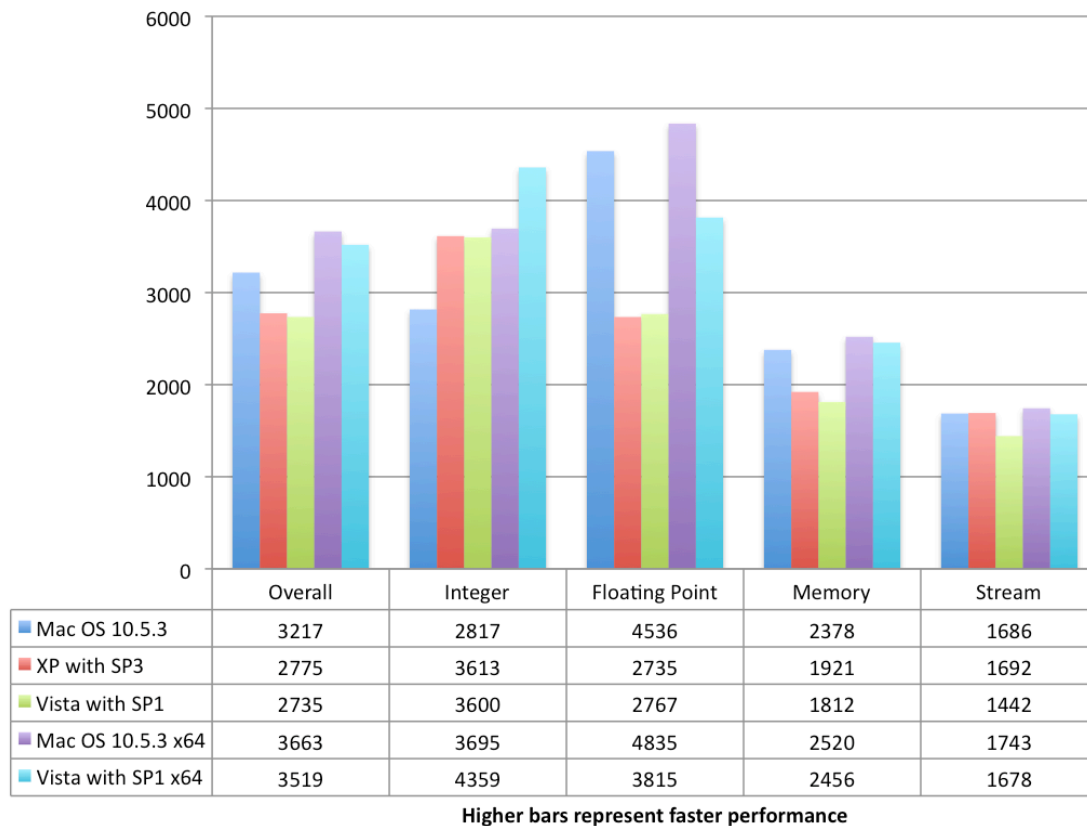
|      | Apple MacBook            | Apple MacBook Pro         | Dell Latitude 630        |
|------|--------------------------|---------------------------|--------------------------|
| Cost | \$1401                   | \$2524                    | \$1335                   |
| CPU  | Core 2 Duo, 2.2 GHZ      | Core 2 Duo, 2.5 GHZ       | Core 2 Duo, 2.2 GHZ      |
| RAM  | 2 GB                     | 4 GB                      | 2 GB                     |
| GPU  | Intel GMA X3100 (shared) | GeForce 8600M GT - 512 MB | Quadro NVS 135M - 128 MB |
| HDD  | 150 GB                   | 200 GB                    | 120 GB                   |

**Table 3 - List of Laptops**

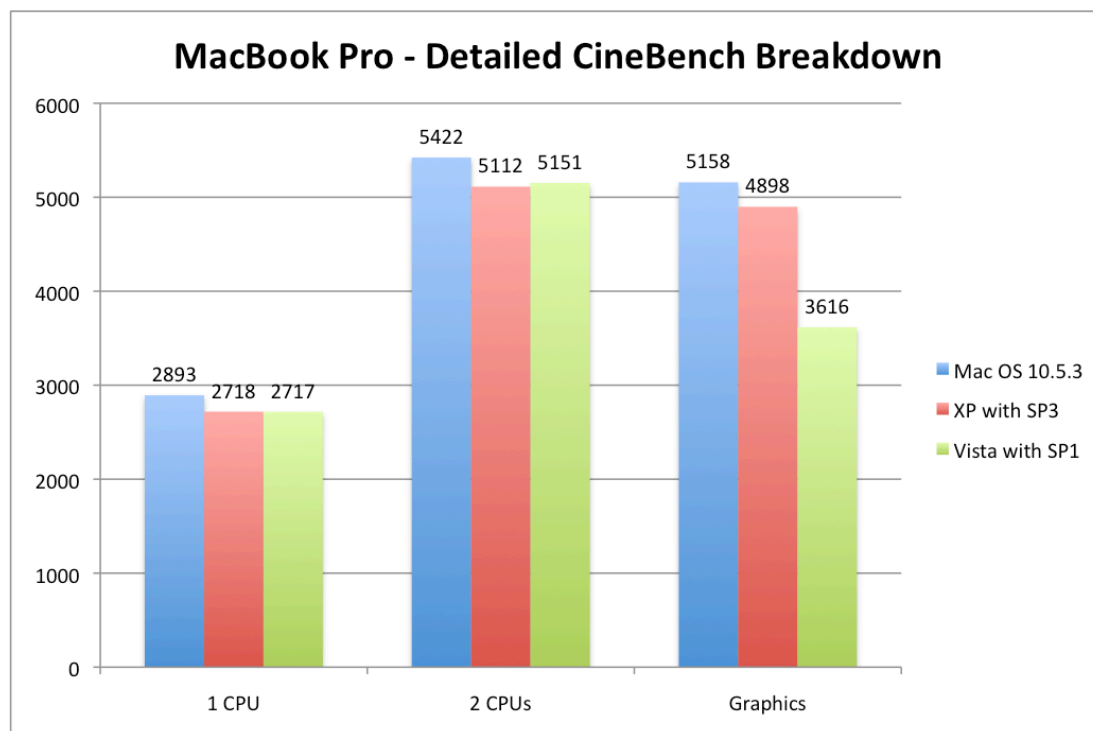
## FIGURES



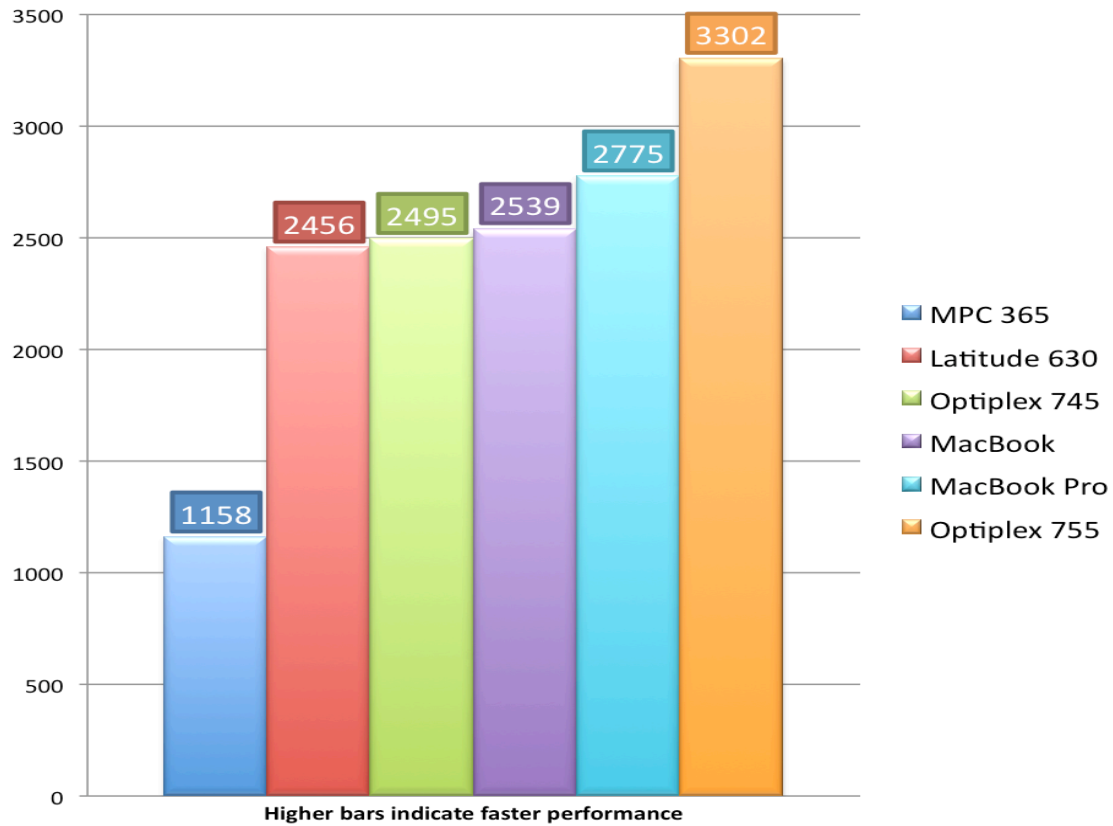
**Figure 1 - Comparison of 32bit Operating Systems on Apple hardware**



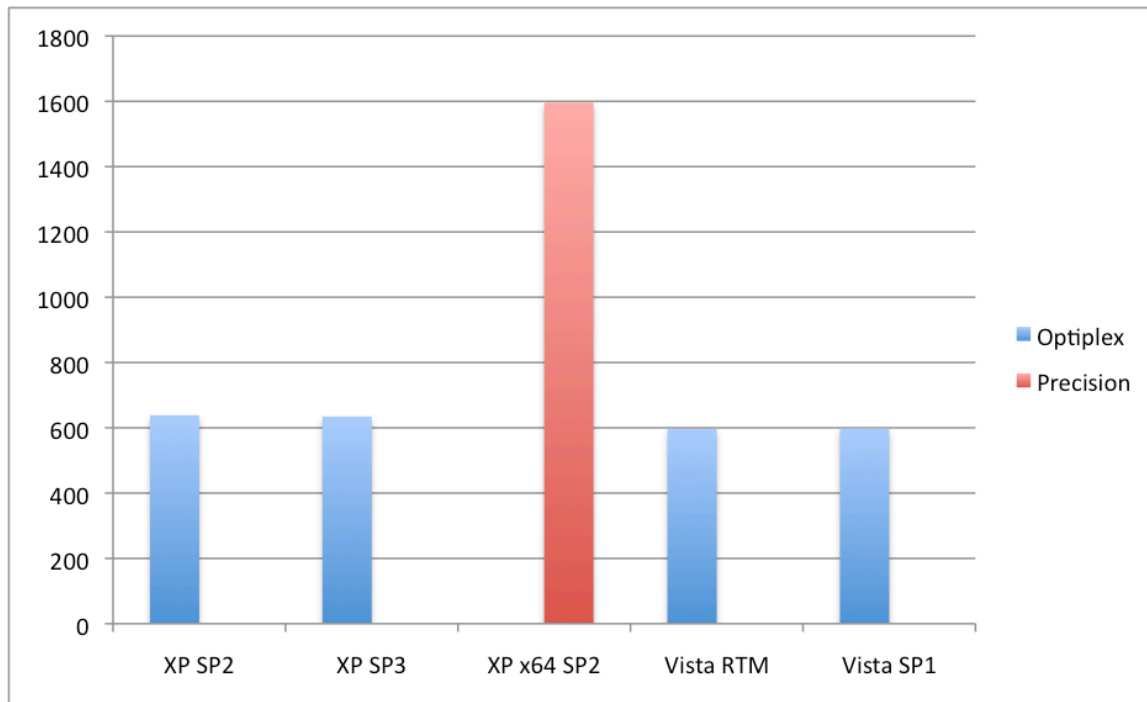
**Figure 2 - Detailed GeekBench scores on MacBook Pro**



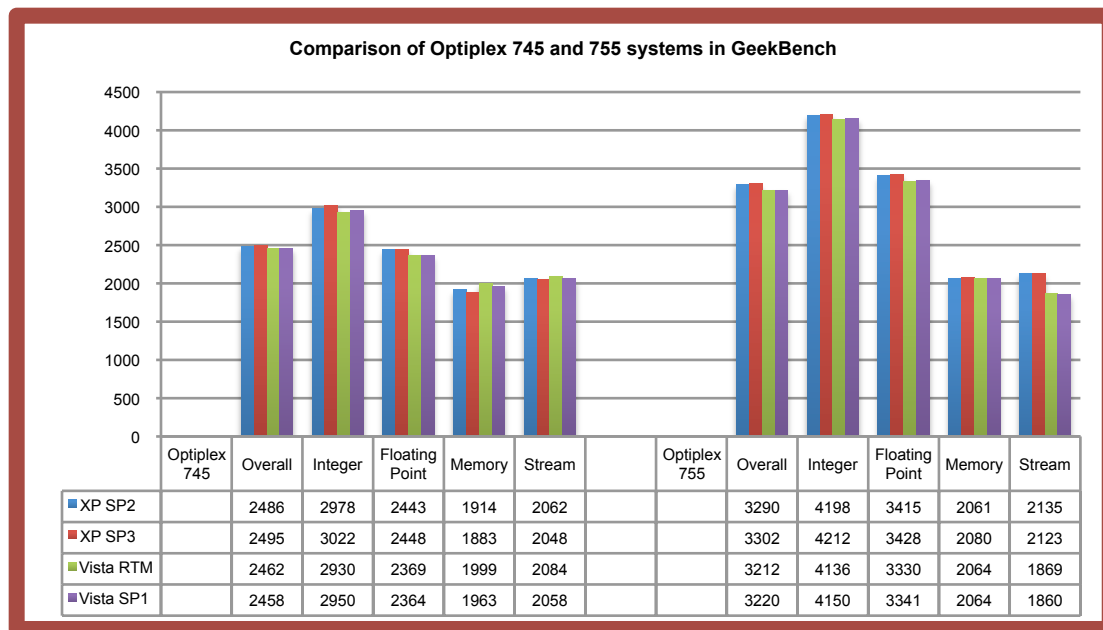
**Figure 3 - Detailed CineBench scores on MacBook Pro**



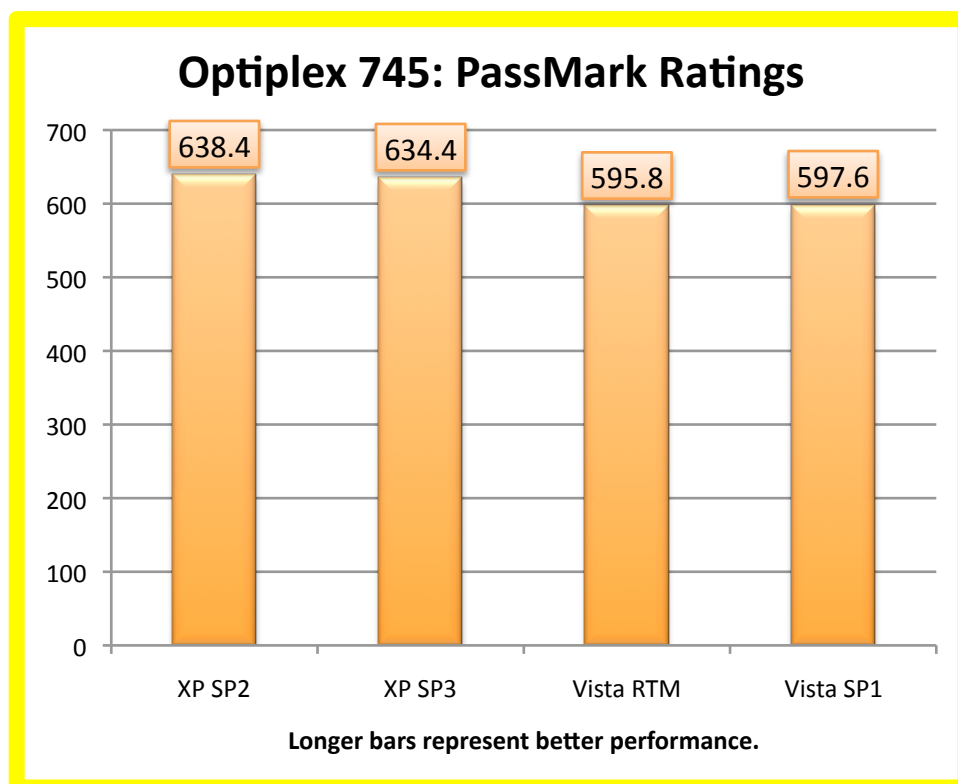
**Figure 4 - Windows XP with SP3 on different hardware (GeekBench overall scores)**



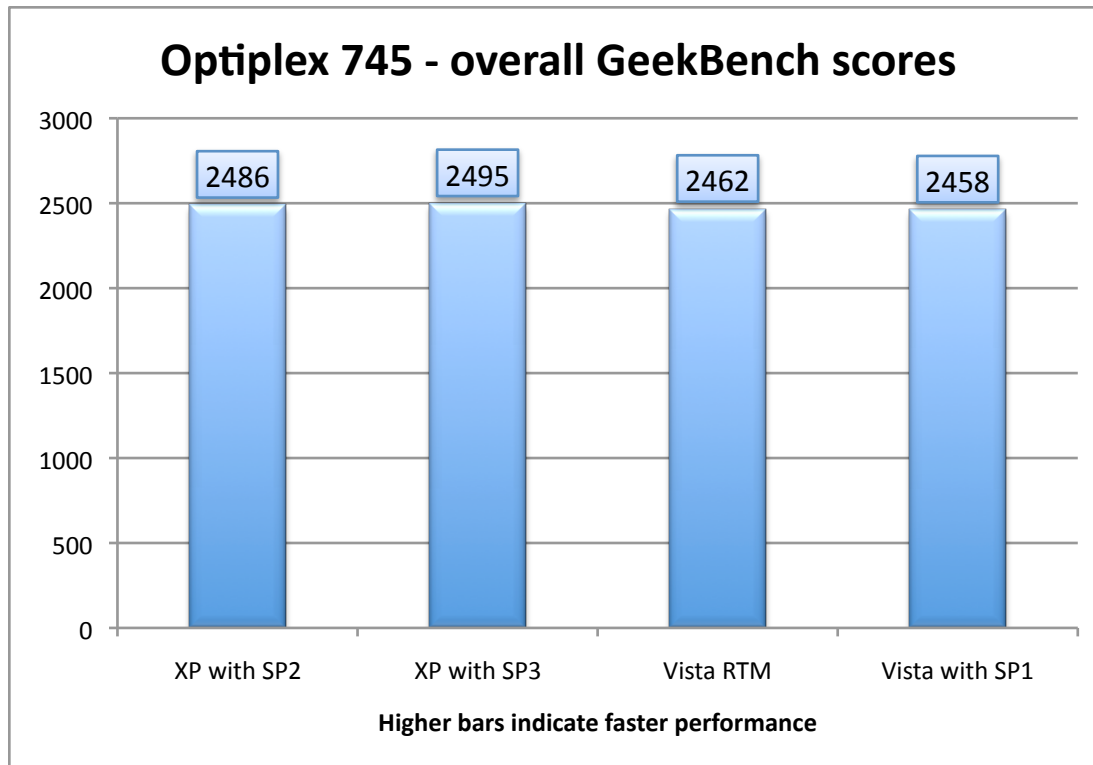
**Figure 5 - Comparison between Optiplex 745 and Precision desktops (PassMark overalls)**



**Figure 6 - Comparison of Optiplex 745 and 755 in GeekBench**



**Figure 7 - Comparison of Windows XP and Vista on Optiplex 745 in PassMark**



**Figure 8 - Comparison of Windows XP and Vista on Optiplex 745 in GeekBench**